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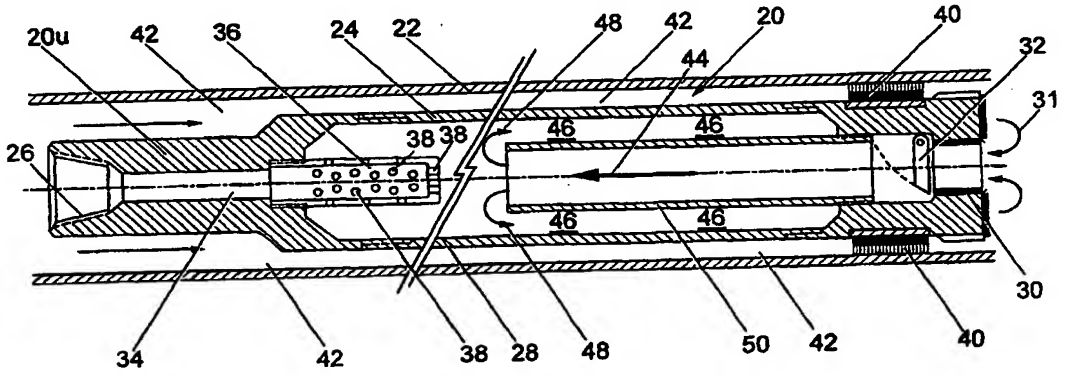

(57) Abstract

A tool and method for circulating fluid within a borehole wherein fluid is passed down an annulus between the tool and the borehole, the fluid being returned to the surface through the tool whereby it may be recycled. The tool typically includes a cavity in which particles the fluid being returned to the surface through the tool whereby it may be recycled. The tool typically includes a cavity in which particles of dirt, drill cuttings or the like are collected. The tool may also include a filter to prevent larger particles of dirt etc. from continuing upward to the surface. The tool may also include a trap to prevent particles of dirt etc. from returning into the borehole from the tool.

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A REVERSE CIRCULATING TOOL FOR CLEANING A WELL

The present invention relates to a tool particularly, but not exclusively, for circulating fluids in wellbores. The tool can also be used for circulating fluids in other bores such as pipes.

When oil or gas drilling operations have been completed and the wellbore has been lined, the bore is cleaned to remove dirt, drill cuttings or the like which accumulate during drilling and lining operations. Cleaning takes place before production commences, as the cuttings from these operations may contaminate any hydrocarbons recovered from the well.

Conventionally, a circulating tool is attached to a length of drill pipe and then inserted into the well. Fluid is then pumped down the drill pipe and into the well through the circulating tool. The fluid then flows upwards in the annulus between the wall of the borehole (or the casing of the well) and the tubing string, washing the cuttings and the like upwards.

The lengths of drill pipe from which the circulating tool is suspended may range from a typical inside

diameter (ID) of 5 inches (127mm) nearer the top of the bore, to 3½ inches (89mm) lower down. The maximum flow rate through the drill pipe (and thus the circulating tool) will be restricted by the ID of the drill pipe lower down.

The casing is generally made up of lengths of liner which are cemented (or otherwise attached) to a wellbore 10, as shown in Fig. 1. The ID of each section is generally larger than the next section lower down the well. For example, a casing section 12 nearer the top of the bore 10 may have an ID typically in the order of 8½ inches (215mm). The casing section lower down the well may have an ID typically of the order of 7 inches (178mm).

Steps or ledges 16 are created in the casing by the reduction in ID of the adjacent casing sections. Particles of dirt, cement, drill cuttings and the like may collect on these steps 16. These particles are difficult to remove from the steps 16 as they are outwith the normal fluid path.

In accordance with a first aspect of the present invention, there is provided a tool for circulating fluids in a borehole, the tool comprising a body for insertion into a borehole and to define an annulus between the body and the borehole, the body having a conduit with an inlet for passage of fluids therethrough, whereby fluid passed through the annulus can pass subsequently through the conduit.

The tool can optionally have an annular cavity for collection of particles, located between the conduit and a sleeve connected to a lower section of the conduit and terminating within or continuous with the

conduit, so as to allow fluid flow between the cavity and the conduit.

The body is preferably provided with a sump. A sleeve is typically located in a lower part of the conduit to form an annular sump between the sleeve and the conduit. Particles of dirt etc preferably collect in the sump.

A filter is typically located in the conduit and typically comprises a baffle. The baffle typically has a plurality of apertures. The apertures are typically of the order of ⅛ inch (approximately 3mm) in diameter. The filter is preferably located in an upper portion of the conduit, and prevents upward passage of cuttings.

The conduit may be provided with a valve to retain cuttings but to allow fluid passage. The valve may comprise an array of spring-loaded fingers arranged at the inlet, allowing passage of fluid and cuttings into the conduit, but retaining the cuttings or debris which would otherwise fall back into the well.

The body is typically provided with pipe cleaning means. The pipe cleaning means is typically in the form of brushes attached to the exterior of the body.

The fluid is typically brine. Any conventional fluid such as drilling mud or the like may be used.

In accordance with a second aspect of the present invention, there is provided a method of circulating fluid in a borehole, the method comprising the steps of inserting into the borehole a conduit member having a conduit therethrough so that an annulus is formed between the conduit member and the borehole, passing

fluid through the annulus, and subsequently passing fluid through the conduit.

The conduit is preferably a tubular or string of tubulars such as a drill string. The fluid is preferably first pumped down a relatively high volume annulus and then up through the relatively narrower conduit in order to allow a higher volume of fluid to be pumped into the well initially, and at higher flow rates upon passage through the conduit. The higher flow rates on the upward passage increase the turbulence in the flow when entering the relatively narrow tubular and assist in the washing action at the bottom of the tubular where cleaning is mainly required.

The annulus between the conduit and the borehole is preferably sealed above the fluid injection point so as to allow pressurised injection.

The borehole may be cased.

The conduit may comprise a sump for collection of cuttings and the like, and optionally a filter to divert cuttings into the sump and prevent continuing upwards passage of the cuttings through the conduit.

Fluid may also be passed from the conduit down into the well and returned through the annulus between the conduit and the borehole.

The method typically includes the step of circulating fluid down the conduit whilst the conduit is being run-in.

Embodiments of the present invention will now be

described, by way of example only, with reference to the accompanying drawings in which :-

Fig. 1 is a sectional elevation of an exemplary borehole which has been lined with casing; and

Fig. 2 is a sectional view of a downhole tool in accordance with a first aspect of the present invention.

With reference to Fig. 2 there is shown a downhole tool 20 for circulating fluids in a borehole 22, the tool 20 including a body 24 which is provided with means for attachment to a drill string, which in this example is a female box connection 26 provided at an upper end 20u of the tool 20.

The body 24 has a central bore, which includes a chamber 28. The bore comprises a lower section 30 having an inlet 31 which is in communication with the chamber 28 through a flapper-type float 32. As an alternative to the flapper-type float 32, a plurality of spring-loaded fingers may be used. Use of the fingers is preferred, as this allows the tool 20 to circulate fluid in both directions.

The chamber 28 is also in fluid communication with an upper section 34 of the bore through a baffle 36. The baffle 36 has a plurality of apertures 38, which are typically of the order of ⅛ inch (approx. 3mm) in diameter, although any size of aperture 38 may be used.

The tool 20 may also be provided with external brush attachments 40. The brush attachments 40 contact the internal surfaces of the casing liner to loosen cuttings etc on the liner or on ledges 16 (Fig. 1).

In use, the tool 20 is attached to a lower end of a tubing string and run into the wellbore 22. As the tool 20 is being run-in, fluid can be pumped down the bore of the tool 20 to clean the wellbore 22 ahead of it.

Once the tool 20 has reached the lower end of the wellbore 22 (and is preferably close to the bottom of the well), an annular preventer or blow-out preventer (BOP) is closed to seal the annulus 42 around the tubing string and tool 20. Fluid is then pumped into an annulus 42 between the tubing string and the wellbore 22 at an injection point just below the BOP. The fluid used is typically brine as its consistency is not as thick as other downhole fluids, such as drilling mud. Thus, brine can collect dirt and cuttings etc but is not thick enough to solidify and thus block the smaller diameter drill pipe used in the string above the tool 20.

The fluid passes down the annulus 42, collecting particles of dirt and cuttings which are located within the annulus 42. In particular, the fluid will collect any cuttings etc on the ledges 16 created by the liners 12 (Fig. 1), aided by the brush attachments 40 as described.

Fluid then enters the tool 20 through the inlet 31 at the lower section 30 of the bore. As it passes upward through the lower section 30, the fluid passes through the flapper-type float 32 (or spring-loaded fingers). Although this embodiment shows a flapper-type float 32, it is preferable to use a plurality of spring-loaded fingers. The fingers allow for bi-directional movement of fluids through the tool 20.

It should be noted that the function of the flapper-type float 32 (or the fingers) is to prevent any dirt etc which enters the tool 20 from re-entering the annulus 42 during use of the tool 20.

The annulus 42 is a relatively large volume when compared to the smaller volume of the inlet 31. Thus, when fluid goes from the higher volume of the annulus 42 to the smaller volume of the inlet 31, a turbulence is created at the inlet 31 due to the increase in flow rate through the tool 20. This turbulence facilitates improved cleaning of the annulus 42 at, or near, the inlet 31.

The fluid (including any particles of dirt) continues up into the tool 20 as indicated by arrow 44, through a sleeve 50. An annular cavity 46 between the sleeve 50 and the chamber 18 collects particles of dirt and cuttings etc. As the fluid exits the sleeve 50, the cuttings etc fall into the cavity 46, as indicated by arrows 48. Thus, substantially all of the larger particles of dirt, drill cuttings etc collect in the cavity 46. More than one cavity can be provided in a stack or segment arrangement.

The fluid continues in an upward direction and contacts the knock-out baffle 36, having apertures 38. The apertures 38 are of the order of ⅛ inch (approximately 3mm) in diameter. Thus, the larger particles of dirt etc are prevented from entering the drill string above the tool 20. The risk of dirt etc blocking the relatively smaller diameter drill pipe above the tool is therefore reduced. The larger particles collect in the cavity 46 as described.

The fluid then exits the tool 20 through the upper

section 34 of the bore and continues to the surface through the drill string where it may be recycled.

As the particles collect in cavity 46, the tool 20 begins to fill-up. This can be measured at the surface as a pressure increase and it is preferable to remove the tool 20 from the well to clean out the cavity 46 before continuing the cleaning operation. It should be noted that as the tool 20 is being retracted, the particles are held within the cavity 46 and prevented from re-entering the annulus 42 by the float 32 or fingers. The size of the cavity 46 can be modified to accept a larger volume of cuttings etc.

The tool 20 works on volumetric displacement. If 1 gallon of fluid is pumped in, 1 gallon of fluid is retrieved at the surface.

Thus, there is provided a downhole tool which can facilitate bi-directional circulation of fluids. As the tool is being run-in, fluid is pumped ahead of it to clean the well. Once in position, the direction of fluid travel is reversed. The tool is optionally provided with two filtration mechanisms; the first prevents the particles of dirt etc which enter the tool from re-entering the well, and the second substantially prevents dirt etc from blocking the drill string above the tool.

The tool may also be provided with external means, such as brushes, for cleaning the surface of the casing or liner as the tool is run-in or retracted.

Modifications and improvements may be made to the foregoing without departing from the scope of the present invention.

CLAIMS

1. A tool for circulating fluids in a borehole, the tool comprising a body for insertion into a borehole and to define an annulus between the body and the borehole, the body having a conduit with an inlet for passage of fluids therethrough, whereby fluid passed through the annulus can pass subsequently through the conduit.

2. A tool according to claim 1, wherein the body includes a cavity for collection of particles.

3. A tool according to claim 2, wherein the cavity is annular.

4. A tool according to claim 2 or claim 3, wherein the cavity is formed in a lower section of the conduit.

5. A tool according to any one of claims 2 to 4, having more than one cavity.

6. A tool according to claim 5, wherein cavities are disposed beside one another.

7. A tool according to claim 5, wherein the cavities are spaced longitudinally along the tool.

8. A tool according to any preceding claim, wherein a filter is located in the conduit.

9. A tool according to claim 8, wherein the filter comprises a baffle.

10. A tool according to claim 9, wherein the baffle

has a plurality of apertures.

11. A tool according to any one of claims 8 to 10, wherein the filter is located in an upper portion of the conduit, and prevents upward passage of cuttings.

12. A tool according to any preceding claim, wherein the conduit is provided with a trap to retain dirt, drill cuttings or the like in the body of the tool whilst allowing fluid passage.

13. A tool according to claim 12, wherein the trap comprises an array of spring-loaded fingers arranged at the inlet, allowing passage of fluid and cuttings or the like into the conduit whilst retaining the cuttings within the tool.

14. A tool according to any preceding claim, wherein the body is provided with cleaning elements on its outer surface.

15. A tool according to claim 14, wherein the cleaning elements comprise brushes.

16. A tool according to any preceding claim, attached to a tubing string, drill string or the like.

17. A method of circulating fluid in a borehole, the method comprising the steps of inserting into the borehole a conduit member having a conduit therethrough so that an annulus is formed between the conduit member and the borehole, passing fluid through the annulus, and subsequently passing fluid through the conduit.

18. A method according to claim 17, wherein the conduit member comprises a tubular or string of tubulars.

19. A method according to claim 17 or claim 18, wherein the conduit member comprises a drill string.

20. A method according to claim 18 or claim 19, wherein the fluid is first pumped down the annulus and then up through the conduit.

21. A method according to any one of claims 17 to 20, wherein the annulus has a larger volume than the conduit.

22. A method according to any one of claims 17 to 21, wherein the annulus is sealed above the fluid injection point so as to allow pressurised injection.

23. A method according to any one of claims 18 to 22, wherein the conduit member includes a cavity for collection of cuttings and the like.

24. A method according to claim 23, wherein the conduit member includes a baffle to divert cuttings into the cavity and prevent continuing upward passage of the cuttings through the conduit.

25. A method according to any one of claims 17 to 24, wherein fluid is alternately passed from the conduit into the annulus and from the annulus into the conduit.

26. A method according to any one of claims 17 to 25, the method including the step of circulating fluid from the conduit member whilst the conduit member is being run into the borehole.

27. A method according to any one of claims 17 to 26, wherein the fluid is brine.

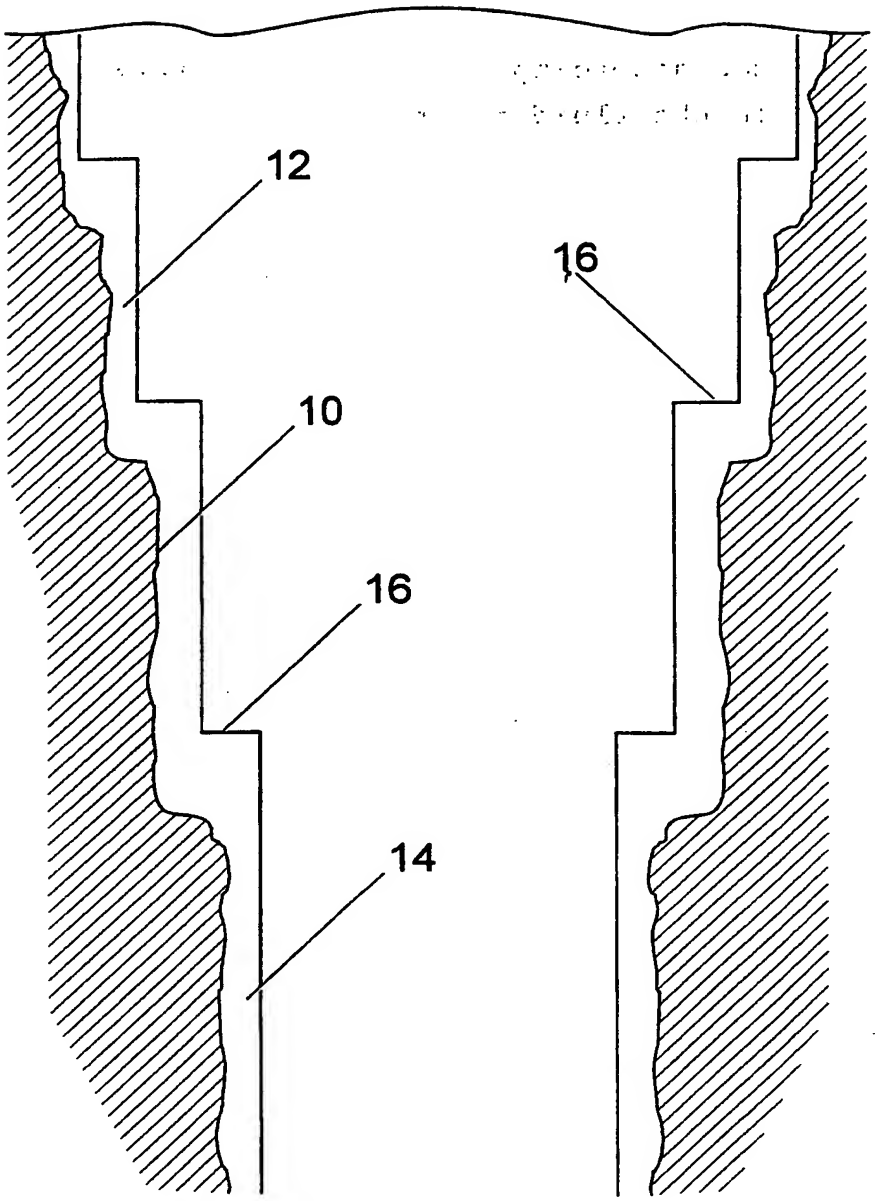

Fig. 1

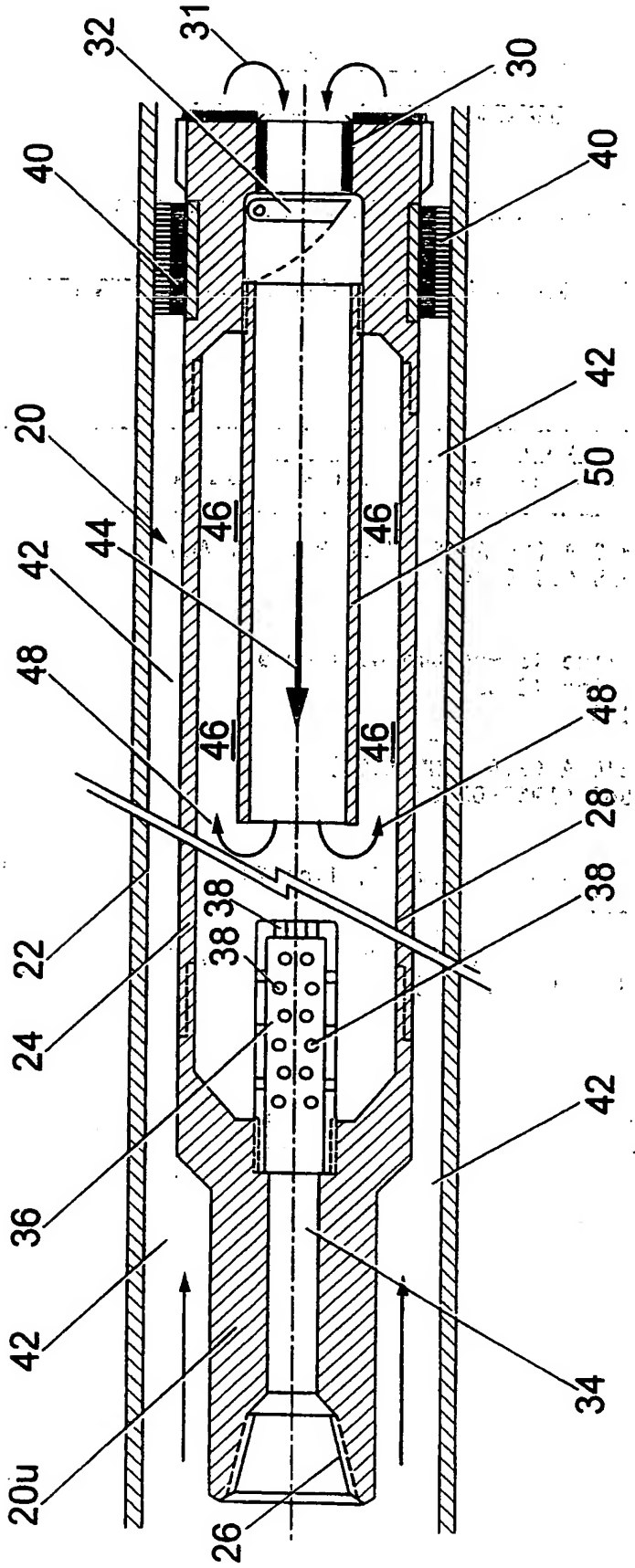
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Fig. 2

INTERNATIONAL SEARCH REPORT

Internat al Application No
PCT/GB 99/02666

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B37/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 402 850 A (LALANDE PHILLIP T ET AL) 4 April 1995 (1995-04-04) column 3, line 43 -column 4, line 9 column 6, line 42-62 figures 1,6 ---	1-4, 8-13, 16-20, 22-27
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X	US 5 318 128 A (JOHNSON MICHAEL H ET AL) 7 June 1994 (1994-06-07) abstract; figure 1 --- -/--	1,16-20, 27

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 December 1999	13/01/2000

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 500 933 A (BURBA JOHN L JR ET AL) 17 March 1970 (1970-03-17) column 3, line 70 -column 4, line 40 figure 1	1,17
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Information on patent family members

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